Space Weather Technical Forecast

Issued on Wednesday, 16 November 2022 at 00:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (Minor to Moderate radio blackouts) throughout. Slight chance of S1 (Minor) Radiation Storms and X-class flares (Strong radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has been Moderate, with numerous mid-upper C-class flares and one M-Class flare observed at 15/0251 UTC, from the largest region on the disc in the northwest (AR3140). This large and complex region is approaching the northwest limb. The region is classified Ekc/Beta-gamma and poses the most significant risk for further flares. AR3141 situated a little further south has changed little in recent hours and is classified Cai/Beta. AR3145 is located in the northwest and has shown some fading in its leading spot. AR3146 in the northeast has declined a little further. A lack of HMI magnetogram data from SDO is compromising the ability to confidently assess magnetic structure within all regions at present.

No significant Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 by DSCOVR, started the period at slightly elevated levels around 440 km/s and has now waned to slow-ambient levels at 380 km/s. Density has been at near to below average levels. The total magnetic field strength (IMF) has been weak throughout remaining below 6 nT. The north-south component, Bz, has fluctuated weakly between +5/-5 nT. Phi angle remained negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2 MeV) at GOES-16 has been at background to moderate levels, with a peak of 414 pfu at 15/1700 UTC. Electron fluence levels remained well below Active (1e8 integrated pfu) levels, with a very slight rising trend. Observed fluence at 16/0000 UTC was 6.01e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to continue Low, with a chance of isolated M-class flares during the period. There is a slight chance of isolated X-Class flares, these most likely from AR3140.

Solar Wind / Geomagnetic Activity: No significant Earth-directed CMEs are expected during the period, though some minor CME effects are possible from a glancing blow on 18 Nov. Solar winds are currently at slow-ambient levels. A further enhancement is possible from weak coronal hole influence during Day 1 (16 Nov) from two small coronal holes. Geomagnetic activity is forecast to be predominantly Quiet through much of the coming 4-day period. There is a chance of isolated Active intervals if we encounter any CIRs associated with the two coronal holes during Day 2, or if we experience any weak CME related enhancements either late on Day 2 (17 Nov) or through the course of Day 3 (18 Nov).

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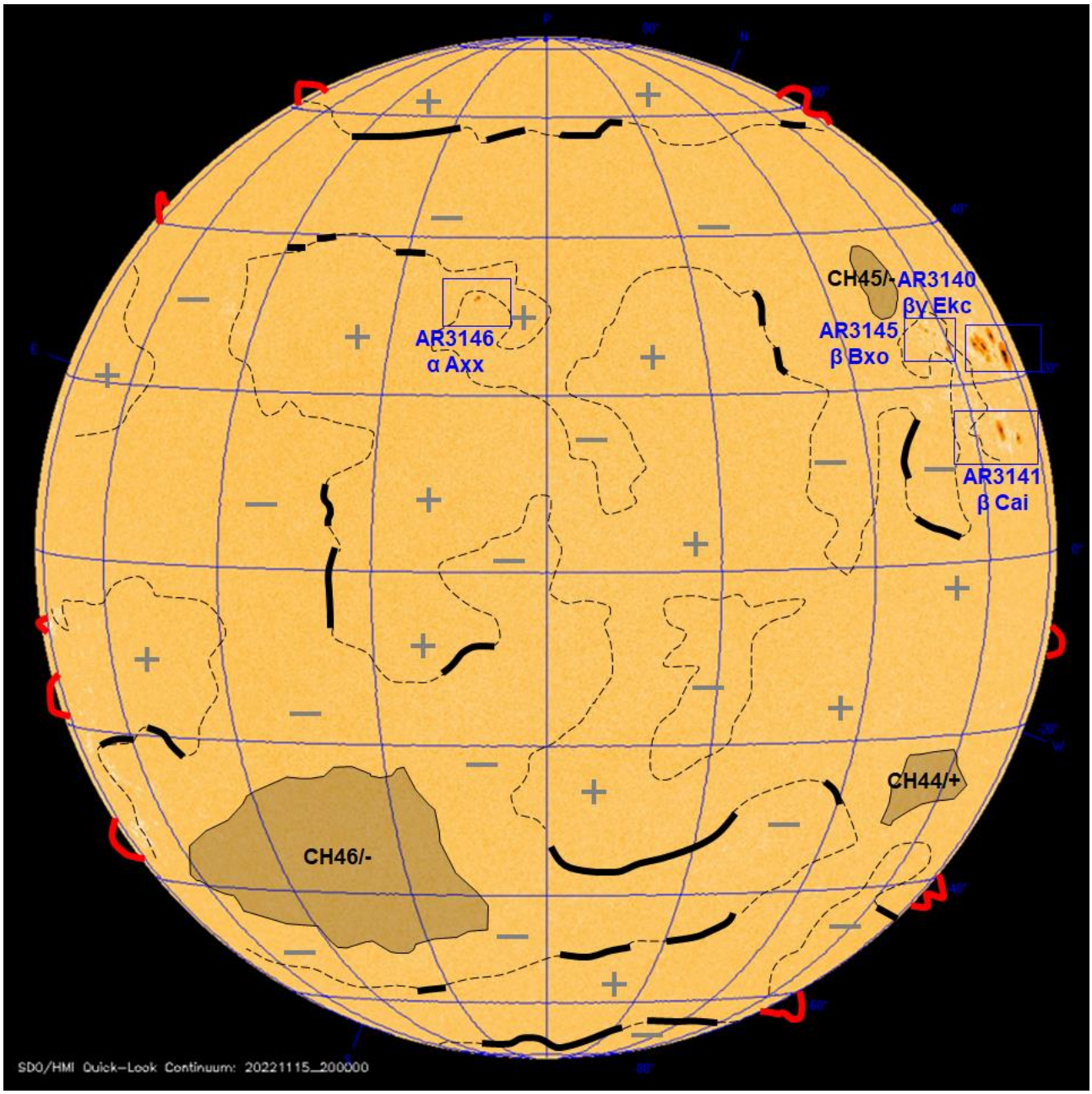
Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES-16 is most likely to remain at background levels throughout. However, there is a slight chance of an increase in solar radiation from AR3140 and AR3141 in the far western solar hemisphere. Electron flux is forecast to remain at mostly background to moderate levels throughout the period. Moderate or perhaps briefly High electron flux is possible at diurnal maxima from Day 2 (17 Nov) onward. Fluence values are expected to remain below or well below the Active (1e8 integrated pfu) threshold throughout the period.

Figure 1. Solar Analysis Valid 2000UTC, 15 October 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

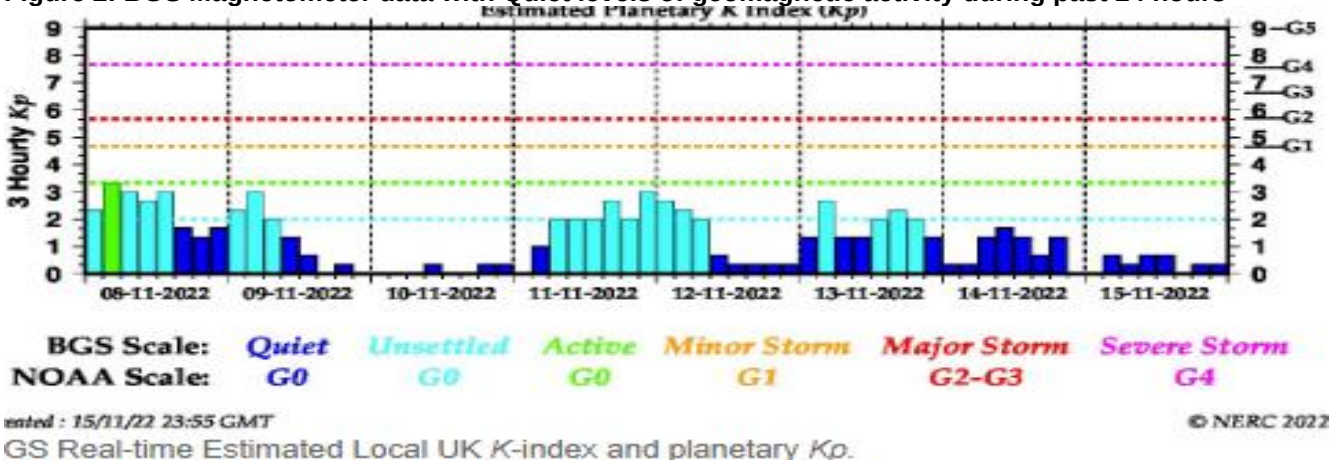
No significant Earth-directed CMEs are expected during the period, though some minor CME effects are possible. Two filament lift-offs were observed on the 13 Nov and 14 Nov, and these are predicted to pass ahead of Earth's orbit, but could give a glancing blow either late on 17 Nov, or more likely, during 18 Nov. Significant impacts are unlikely if encountered at Earth.
Solar winds are now at slow-ambient levels and solar winds might see a further slow decline through Day 1 (16 Nov). A further enhancement is possible from weak coronal hole influence by Day 2 (17 Nov) from two small coronal holes at a similar longitude on the visible disc: CH45/- in the north and CH44/+ in the south. Although it is difficult to tell which of these features may become geoeffective at Earth as they are similar latitudinal distances away from Earth's position relative to the ecliptic.
STEREO-A data suggests a weak CIR was encountered over the last 24 hours, suggesting something similar could affect Earth during Day 1 (16 Nov). Geomagnetic activity is expected to be mainly Quiet in the next 24hrs, with an increasing chance of Unsettled intervals. There is a chance of isolated Active intervals on Day 1 (16 Nov) if any CIRs are encountered associated with the two small coronal holes. A further chance of Active intervals on Day 3 (18 Nov) is possible if we see any weak CME related enhancements.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: BGS Magnetometer data with Quiet levels of geomagnetic activity during past 24 hours



GS Real-time Estimated Local UK *K*-index and planetary *Kp*.

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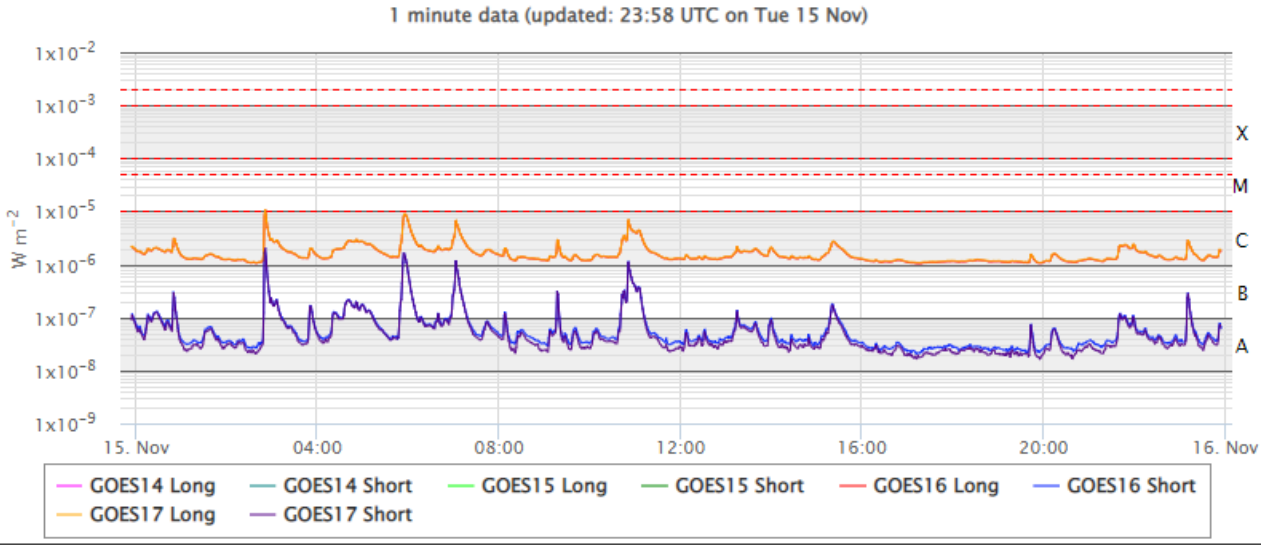
Radio Blackouts - X-Ray Flares:

Solar activity is expected to remain at Low levels throughout the period. There is a chance of isolated M-class flares during the period and a slight chance of isolated X-flares, most likely from AR3140. There are four numbered solar regions on the visible disc. AR3140 approaching the northwest limb is the largest and most complex region, classified Ekc/Beta-Gamma. AR3141 situated a little further south has changed little and is classified Cai/Beta AR3145 again in the northwest, has shown some fading in its leading spot. AR3146 in the northeast has declined a little further. A lack of HMI magnetogram data from SDO is compromising the ability to confidently assess magnetic structure within all regions at present.
AR3140 and AR3141 are expected to fully rotate off the visible disc on Day 2 (17 Nov) and Day 3 (18 Nov) respectively, although they could still pose some risk of flaring until well beyond the western limb. Two new bright regions of flux (evident on STEREO-A EUVI 304 imagery) will probably rotate over the eastern limb in the southern hemisphere during Day 1 (16 Nov), although it is difficult to fully assess the likelihood of flaring from these until they appear on available imagery, which is reflected in the flare probabilities in the table above.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	30	10
Very Active	R3 to R5 X Class	No	10	10	5	1

Figure 3: X-ray flux at GEO from GOES with one M-class flare and numerous C-class flares.



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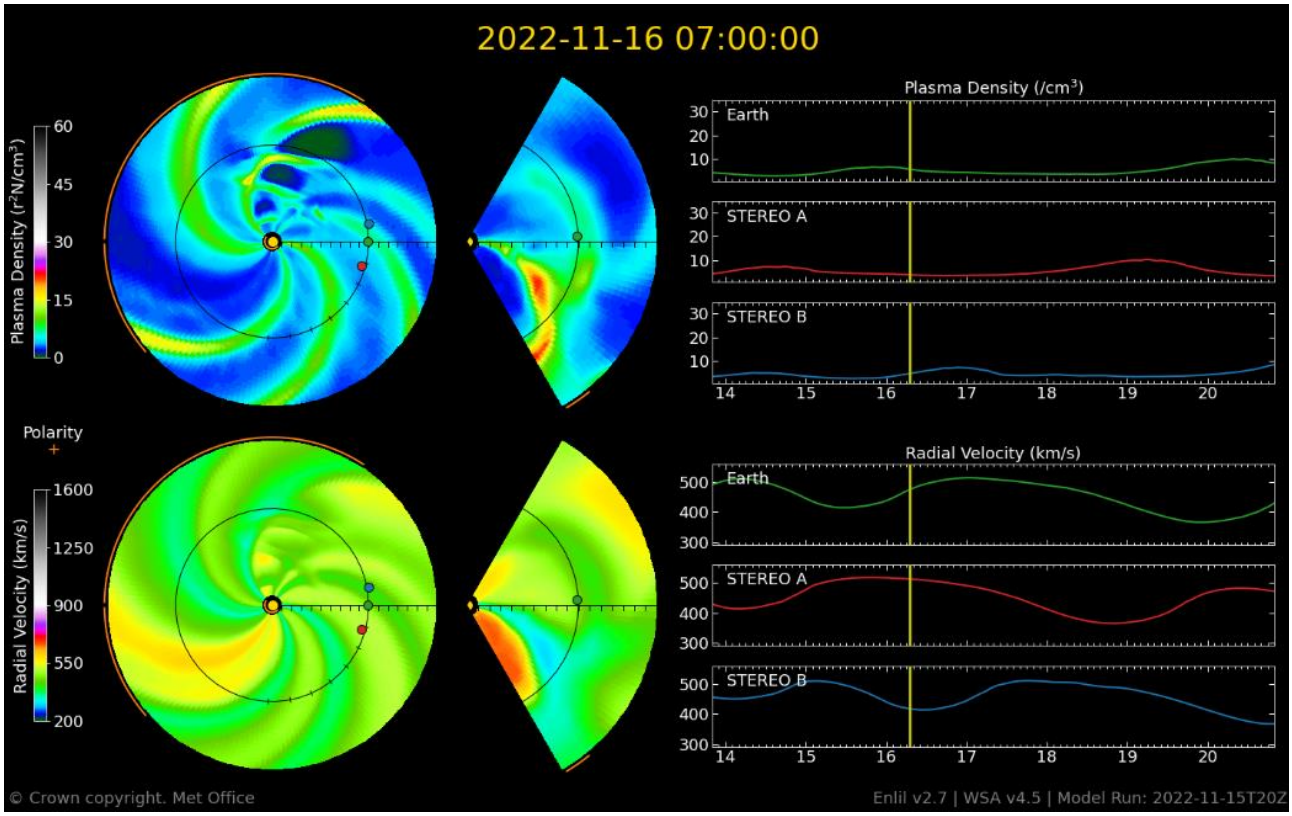
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) at GEO, as observed by GOES-16, is currently at background levels and is most likely to remain at this level throughout the period. However, as AR3140 and AR3141 continue to transit across the western solar hemisphere they will continue to pose an enhanced risk of proton storms over background conditions, and this is reflected in the probabilities given in the table.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Met Office ENLIL model output giving indication of high speed streams affecting Earth.



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High Energy Electrons Event (≥ 2MeV):

Electron flux (greater than 2MeV) is currently at mostly background levels and is forecast to be at background to moderate levels through much of the coming 4-day period. The arrival of weak HSS influence from two coronal holes is probable during Day 1 (16 Nov), although significant charging is considered unlikely from these features. Moderate or perhaps briefly High electron flux is possible at the diurnal maxima from Day 2 (17 Nov) onwards, but persistently high levels are considered unlikely, with reasonable confidence.

Electron fluence values are well below the Active (1e8 integrated pfu) threshold and are expected to remain so throughout the period, with a slight rising trend possible from Day 3 (17 Nov). The MOSWOC REFM output currently supports electron fluence values remaining below the Active threshold with a mostly flat trend indicated which offers good guidance. Fluence levels on the last rotation remained below the Active threshold with slightly faster wind speeds, and a similar trend is considered to be a probable outcome.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output.

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